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Good afternoon. It has just turned past noon here in beautiful Sunnyvale Mountain View at the Ames research Center. I am Jason Kessler. We are starting off our asteroid grand challenge anniversary seminar series. The first session is asteroid hunting. Beginners guide to potentially hazardous asteroids.

We have a really fantastic group of folks joining us both professional and amateur astronomers. The goal today in this session is to explore the potentially hazardous asteroid situation and what amateurs might be able to do in terms of helping what the cause. There is a lot of work already being done both by professional amateurs and for the grand challenge to figure out a way to map out a future that would provide meaningful opportunity for the amateur community to contribute to this issue.

I think to make it easy, we have a very diverse group. I am going to ask everybody that is on the panel to introduce themselves, their name, their affiliation, couple of sentences about themselves, their work, maybe why they got into the asteroid business in the first place, finally make sure we are keeping the conversation somewhat light, let us know if you are a deep impact or a Armageddon kind of person.

I had to do it. I thought it worked pretty well with NASA edge so we will try to have some fun while doing some digging into what might be beneficial here.

Let me go first to Patrick Miller.

Hello Jason. I am Patrick Miller I am with the international astronomical [Indiscernible] collaboration which we nicknamed ISAC we are a group of 20 [Indiscernible] around the world professional observatories, a group of amateurs. What we do is provide data for students who are at colleges and universities some middle schools where they look at the data and search for and make asteroid discoveries.

Currently we are in about 500 schools in more than 70 countries and over the year best year since we have been in operation we have [Indiscernible] main asteroid discoveries in one PHA discovered a couple of TMOs and a comment.

In terms of the impact or Armageddon I guess I am a deep impact or. -- Impactor. I started this in 2006 not for any particular reason other than to make this discovery available to students.

Fantastic. Thank you Patrick.

We will move on to Brian Warner.

Thank you Jason. My name is Brian Warner and not the Brian Warner also known as Marilyn Manson. [Indiscernible] university of south Africa. I like to make that distinction.

I work for the center of solar system studies a collaboration amongst amateurs where we concentrate on solar system study. I work on near Earth objects [Indiscernible] concentrates on [Indiscernible] we are having lots of fun with all that. That is our primary work is to get [Indiscernible] of these objects determine rotation rates. I try to take it further and analyzed with the rotation rates are telling us the statistics of the rate and so on. I also maintain the [Indiscernible] database which is used by asteroid researchers around the world which is a [Indiscernible] of rotation rates and other information. [Indiscernible] to do the research on the asteroid population.

As far as the movie goes whichever one [Indiscernible] if they are on at the same time then I watch the other during a commercial break.

Good enough. Thank you Brian.

Let's move next to Carl.

Hello Jason. I am Carl Hergenrother I am the associate [Indiscernible] scientist at the University of Arizona planetary lab. I've been involved in asteroid and comet search for 20 years as an undergrad but I have been interested in mostly, it's because you can observe them in your backyard going back to my dad gave me my first pair of binoculars to play with.

In addition to being a professional astronomer I am heavily involved with the [Indiscernible] Association planetary observers and a few other amateur groups like [Indiscernible]. I do like to sit in my backyard and observe stuff for fun as well.

Most of my research has been on the rotation rate of very small asteroids. Asteroids are [Indiscernible] with what our mission is all about. Over the past 10 years I've been working on the [Indiscernible] mission which is a NASA mission being run out of the University of Arizona. It goes to the nearest asteroid collects samples from it and brings it back to earth. As part of my job here at [Indiscernible] science program called target asteroid. Where we actually engage amateur astronomers to observe and study asteroid points that might be [Indiscernible] in the future. In fact we have actually worked with Patrick Miller [Indiscernible] program as part of our program.

Already some connections I did not know about. This is great.

Let's move next to J.

Hello my name is Jay Tate. I [Indiscernible] in the UK which is also the national [Indiscernible] information Center. I got involved in 1996 when it became [Indiscernible] play the game. Since then I have been a consistent pain in the but for the government and various other [Indiscernible] to try to get something done. We have also helped set up school programs with [Indiscernible] project with [Indiscernible] and international school observatories. [Indiscernible] as far as [Indiscernible] it has the Armageddon every time.

Did we let Carl slip by without a movie selection.

I have actually never seen either of those movies. Actually little snippets I guess I would do deep impact is there is a comment involved.

There are enough thank you for your honesty.

Let's move next to Peter.

My name is Peter Birtwhistle I run the [Indiscernible] Observatory which is in amateur Observatory in England. I'm about 50 or 60 miles west of London [Indiscernible] every time I can. And concentrating on following out [Indiscernible] asteroids so [Indiscernible] have been discovered by the NASA surveys generally. I have been doing that for just over a decade now. But was doing positional work on comets and asteroids back into the 70s with film and stuff like that.

I think I deftly would have to be a deep impact person going to the observatories running out after [Indiscernible] discovery.

Thank you.

Finally rounding out at least in the video Paul Cox Hi Jason. [Indiscernible - feedback, echo] I managed our Observatory in England [Indiscernible]. [Indiscernible] research group which is [Indiscernible] [Indiscernible - feedback, echo] we have been tracking [Indiscernible] asteroid since [Indiscernible] when we first started [Indiscernible] been around 2008 [Indiscernible] as it flew over the Observatory before going into the [Indiscernible] desert.

Movie toys. Armageddon music, deep impact [Indiscernible] because we have more warning. Wasn't there more warning in deep impact?

Fair enough. Thank you.

Our last panelist Brian Warner -- Brian day.

I and the other Brian. My name is Brian day in I am here at NASA solar system exploration research virtual Institute. I was a long-time amateur astronomer and one of the hats that I wear here at [Indiscernible] is developing amateur professional collaboration and citizen science efforts.

I got to participate in the L cross mission so we had a nice sizable learning -- lunar impact and during the last mission we had a Chordata campaign of absorbing -- observing meteoroid impacts on the moon so it has some relevance to our discussion here.

In terms of movies I'll had to be very frank with you Jason, I am actually a Monty Python kind of guy.

Hand me the holy hand grenade. Thank you.

As those tuning in can see we have got a really powerful group here. I think with the experience and interest, we will hopefully be able to dig into some profound conversation how we build off the stuff that is already happening and continue to grow their.

What might be useful is to start out with a question around what does it really take to hunt asteroids.

I am not asking so much about the initial discovery because I think it is pretty clear when we are talking about engaging amateurs, the opportunity for new discovery will only diminish over time. It is a very small percentage at this point. It is really to focus in on what does it take to do follow-up work and characterization work. Why don't we walk back and I will start with Ryan date first to lead us off here.

Since he is probably too modest to do it I will hold up right now one thing you should have is the light [Indiscernible] and analysis but by Brian Warner. If you are going to really understand some critical things about Earth asteroids being able to view this type of [Indiscernible] were amateurs can have real great role.

Of course there are other areas such as doing [Indiscernible] work that has been very -- some excellent work has been coming out of IODA and of course the stony -- astronomy has been mentioned.

One thing I like to talk about is every year a number of near Earth asteroids into becoming very small asteroids that actually hit the earth. We have here several networks. We have the NASA all sky fireball network back east and out here on the west through the study Institute we have the CAMS program. Amateur [Indiscernible] can dissipate in detecting these as they are coming through the atmosphere and with the inappropriate overlap with inexpensive video set up you can ask to determine not only the three-

dimensional path coming down through the atmosphere but where it landed and also it orbit in space before it encountered the earth.

This helps us find these objects when they hit the ground and not is of great interest in terms of characterization. We have organized several teams that have actually gone out when there has been a fall in the area and [Indiscernible] we get together and we put together rubes and you have a large number of people all lined up walking across a farmer's field looking for the rock.

That is good.

But also being able to go back and characterized it orbit in space. The amateurs have been able to actually find several new streams that we did not know about the four. Stream of debris that are intersecting the orbit of the earth.

These are interesting areas and looking for asteroids you don't always have to look up sometimes looking down is good to.

Thank you.

Anybody got a burning desire to jump in and build on that. I saw Carl shaking his head. Brian, the second Brian.

I think one thing that would be nice to mention is that it doesn't require really big telescopes either. I think some folks might imagine they have to have these humongous backyard telescopes. There is asked -- excellent work that can be done with [Indiscernible] size 6-12 inch size [Indiscernible] telescope or other automated telescope it is just a matter of picking target which I think all of us here and other resources on the net are glad to get you excited on those lines.

It is more a matter of I think dedication to sing okay I am going to start a program and then follow through on it. To just go out and randomly do things I used to look at [Indiscernible] and then I got tired of that and I started looking at asteroids.

[Indiscernible] I think it gives you focus if you pardon the expression to try to join like Carl's [Indiscernible]. You will list in the [Indiscernible] Bolton which is available for you online that he produces every quarter and of course get in contact with him and he can give you all of the background you need for [Indiscernible].

Again, it does not take a whole lot in relative terms to get going and contribute. That is what we would like to encourage everyone who is listening, if you're not already interested to try to get that way and contribute to this great science.

Another thing to add on to what Brian said, concentrating on potentially hazardous asteroids and small targets that spacecraft or hopefully humans can go through that small part of a much larger population that ranges from a very large asteroid like [Indiscernible] down two small pieces of dust that hit us during meteor showers.

In order to learn more about these objects [Indiscernible] for science or that are bigger hazards you have to study the entire population. Even just no telescope at all using your eyeballs sitting on the lawn chair gifting count meteors and not is still a very productive scientific endeavor and one that I do for fun as well. That is the most relaxing form of astronomy out there.

Even with a small telescope even starting Desmet betting a [Indiscernible] will tell us what we don't know because [Indiscernible] at different angles that we want. By observing some of the bigger objects specially ones that might have been the original parent of the near Earth asteroids we are studied you learn a lot more about the population in general. Even if you don't have a big enough telescope to study a 20 m object [Indiscernible] NASA is interested in forearms there are plenty object out there that you can study that are much bigger and brighter which will actually inform us and add more to our knowledge of the entire population.

I think if I could just get in. One of the other things is it does seem to members of the general public this is a bit of a black art. One of the things we do here is show people how it works. We can do that in less than an hour. We have had quite a few certainly amateur astronomers who have gone away thing I can do that. If you show them how it is done, give them the references for the software, tell them what they need, show them how it is done just very quickly, they realize that it is really not that hard.

To be really good at it it takes practice and time and so on, but to get started it is really not that difficult. When I thought of getting into this it seemed like you have got to be some sort of geek to get into that. It is not that difficult to get started. If we can explain to people it is easy, you will not be a genius straight the way amah but you can get started fairly easily with a fairly small scope with a decent camera off you go.

[Indiscernible] we tackle that very issue because what we found [Indiscernible - feedback, echo] one of the things we found is [Indiscernible] people interested in doing it and people who knew how to do a. [Indiscernible - feedback, echo] the educational side of this so we have constructed graduation process. We found just giving people [Indiscernible] learning documents is insufficient. A lot of people need a level of handholding. And [Indiscernible - feedback, echo] until they graduate and they can [Indiscernible]. They proved they can do it [Indiscernible] [Indiscernible - feedback, echo] .

We used to [Indiscernible] in the Canary Islands and in Chile [Indiscernible]

[Indiscernible] system [Indiscernible - feedback, echo] since we were here last September we actually put together a system we were talking about where it group of members were studying [Indiscernible] [Indiscernible - feedback, echo] date go in court made observation with [Indiscernible] use of those telescopes [Indiscernible - feedback, echo] we have several members [Indiscernible] near asteroids on the same night.

Those are the things we found educated people [Indiscernible] to allow them to work together in teams.

What we found is if you have the telescopes and we have we have been using the 2 m [Indiscernible] telescopes [Indiscernible] and the Liverpool telescope in the Canaries, we have had eight, nine, 10-year-old kid doing really good astronomy. The kids love it, the teachers love it, this is the way to go.

Paul, can you mute your microphone?

I had a couple of things I want to comment on. J is right about it being fairly easy. We train around 5000 students a year around the world many are middle school students. Most are high school and college students. It takes a couple of hours. We have online instructions and they download that, the software and in a couple of hours they are experts if they need assistance we have online assistance to provide.

You are right it does not take much to train them to do some very fine astronomy.

In terms of [Indiscernible] we don't do much of that. We do a lot of follow-ups. In fact one of our collaborators the astronomical research out of Illinois there is about 30 targets and night [Indiscernible] on behalf of NASA and we distribute those images out to the schools. The students will major the [Indiscernible] target answers around in the background for other discoveries.

You can bring lots of students and the general public as well into this process and in short order have them do some fine work.

I would like to say something to follow up on what Brian Warner was saying earlier on when he was saying people looking at deep sky objects a lot. One of the things about getting into asteroids is things are different every night you go out. There are different targets there is a lot going on out there. There is a lot of amateur equipment being used [Indiscernible] other things. I'm sure if people can get the bug and concentrate on the good program like Brian is talking about there is a lot of work that can be done. A lot of people can be brought to bear on some of these problems.

I think [Indiscernible] made and others about collaboration is extremely important so there is a coordinated effort [Indiscernible] target asteroid [Indiscernible] Paul does. I

started and online site years ago called the Paul site which [Indiscernible] which people would know who is working what. That is a minor resorts down -- to what is available out there. The Internet is a wonderful thing for the most part. Make use of all the resources out there.

One example that I would like to call attention to is the lunar meteorite impact observation campaign. As mentioned by the other speakers, the resources involved are fairly modest. 8-14 inch telescope does wonderfully to observe the flashes of impacts on the moon.

Again having a coordinated effort as people mentioned there is a coordinating effort done I be associated -- Association of lunar planetary observers there is a [Indiscernible] section there also help by NASA's meteoroid environment office out of Huntsville Alabama [Indiscernible]. That is a wonderful example of how there are areas of really cutting edge science that amateurs can participate in and can make a big difference with modest amounts of equipment.

One of the things that I am hearing clearly is that it is not necessarily as hard as we think it is for people to participate. There is a certain amount of education involved. There is a certain may be tearing where people build skill over time on larger objects and then getting to smaller or harder to track objects.

One of the interesting things I hear is there is a lot going on but maybe not as well coordinated as we could be. Is that an opportunity for us to come together and say we can marry resources or leverage the things that are already happening in a way to make it easier so we are out talking about now the asteroid redirect mission or grant challenge or any of you are out in conversation and there is an easy place for people to start. I don't know if that exist at this point. I am curious if collaboration or coordination a hurdle we can focus on?

I definitely say so. You have a [Indiscernible] primus things are all [Indiscernible] when it comes back I think. There really isn't that kind of thing for a common tree along those lines and certainly there could be a greater coordination for astrometric programs.

Even on this Mac side it took a long time [Indiscernible] asteroid surveys to start actually corning together and [Indiscernible] that was a major effort that the planet Center push through. They also help coordinate [Indiscernible] they have a log as observers are observing objects may [Indiscernible] to make sure other people don't observe it as well.

We deftly need [Indiscernible]. All of the hooks are in place. We have got calls, we have target asteroids we have the database therefore the minor planet Center, but it would be nice to tie all of these things together and to go out in the amateur community and here is an object [Indiscernible] here are a series of objects we are interested in tonight that need to be observed. As they get observed to get checked often you go to the next one.

The point there were he said [Indiscernible] I'm usually start thinking you put out one object you get about 5 million observations and nobody is looking for anything else. We need to do something like that so if something does come along [Indiscernible] that is going to be coming by for a couple of days we get a coordinate a campaign going. There are a few million others out there that [Indiscernible].

There is a great deal of time to reinvent the wheel. [Indiscernible - feedback, echo] 's brilliant education brilliant instructions [Indiscernible] national school [Indiscernible - feedback, echo] the same stuff. How you coordinate that is [Indiscernible - feedback, echo] it is slightly difficult. Because [Indiscernible]. If we suddenly got I don't know half a dozen different programs all telling you how to do it it is going to get very confusing.

I agree.

My bottom line goal is to [Indiscernible] whatever you did go to metric data or [Indiscernible] data instead of getting fed to essential database for future research. [Indiscernible] now hosting a database of asteroid like group data using a format that I helped develop. Regardless of who coordinates the efforts or anything I think to me the important thing is getting the data into a central database such as the [Indiscernible] became essential point of all of astronomy.

The worst thing on planet Earth is to have a old dusty filing cabinet as we call it namely a hard drive full of data that never goes anywhere, never sees the light of day and all your work is [Indiscernible] but nobody else benefits from its.

I would also like to add it would be nice to have a centralized depository for data itself. The actual image data. Right now [Indiscernible] surveys that are in existence no image is useful. There is deftly astrometric but there is important photometric data in every image. It would be nice to have that data somewhere where research in the future can even better catalog and go through it. We analyze data and make discoveries that we missed the first time through.

There is a whole side -- I will sit on asteroid all night long and get the [Indiscernible] out of it because I don't have time for other things [Indiscernible] images aside but I still keep them. There are several programs that I have written or others have written you go back to look for variable stars in their. I made about 12 Discovers That Way that were not in the international star database by the [Indiscernible]. Data mining is a tremendous project with existing images let alone those for the future.

I think we are missing a trick here. By missing the distinction between the tree sorts of people who are going to do this, the casual observer who was to have a quick go and get some decent data, the enthusiast who really wants to do it on a regular basis, and the real

[Indiscernible] expert who doesn't nearly all the time and is brilliant. We have got to decide what resources go to which group.

[Indiscernible] sort themselves out the central repository of data and results it doesn't matter where those results come from Shirley.

No it doesn't matter where the results come from but you had to get the results in the first place. [Indiscernible] encourage [Indiscernible].

The enthusiast and probably -- are probably the two main targets. The worst group of people become casual and then elevate to enthusiast. If you get to that level they will do it anyway.

What we found with the schools and the public is they are quite happy to get going and do a few then they get bored and move onto something else it is those people we have to hook.

I think we managed to do that. I think we do that because they work in teams. That seems to be the team itself provides a level of motivation within the team that keeps people stuck in its. We have actually been asking some team members have you thought about [Indiscernible] to start your own group but actually they are very happy and comfortable in that team [Indiscernible] leaving behind some of their body of work. I think it is something you would not get working as an individual because as soon as you leave the environment where you are being taught for an hour and then suddenly you are on your own I can understand why that would be a little bit demoralizing maybe even a little bit [Indiscernible] but these guys are driving each other on to improve results, improve the way they do things, improve how they bring people into it.

I think we have it on a solution a recipe for this that works really well. It is that group collaboration.

I think another key is to get as many people in the front door as possible. We will lose people along the way even the enthusiastic amateurs even professional astronomers. All of us have a habit of having an addictive personality we jump into a project and we put all of our resources into it for five or 10 years and then either we get bored and move on or we get married and have kids something like that and we lose time. Or you just go on to something else. There are always more more people going through the front door and that is what we need to do is to keep the conveyor belt going. You are going to lose people along the way but you will gain more people.

One thing we see when we have the campaigns for the schools is that school will start off with 20 or 30 kids involved and you will see the [Indiscernible] reports, cross the desk that will have lots and lots of names on them. By the fifth week we are down to two or

three. It is those two or three that we see come back year after year. In fact we have had some of them go to college and go out and start their own programs in the schools where they are now teaching.

Certainly that group who sticks around and works as a unit is who we are looking for.

There are a couple of questions that we have been asking quite a bit here at NASA dealing with basically how can we facilitate this, what can the role of the grand challenge the?

This seems like the question we are seeing here is issues of coronation of effort and coronation of data.

In terms of coronation of effort, we are seeing right there amongst the people in the panel that there are excellent programs out there and perhaps NASA can use it reached and cachet to publicize this and get more people wear these programs.

In terms of the coronation of data, we were talking about these repositories of image information, photometry. I couldn't help but think of Nash's PDF the planetary data system. We have an example here and perhaps we can uphold this example and lessons learned in help in establishing a common data repository for people who are involved in these efforts with asteroids.

When we [Indiscernible] for the workshop last year [Indiscernible] was with this and making a presentation to the workshop, we certainly spoken and [Indiscernible] not in the meantime, [Indiscernible] first of all they showed great interest in taking on this role back then and they have expressed that since. Surely that has to be one of the leading contenders [Indiscernible]. I believe personally that the collaboration of observation and the data collaboration has to be done together because one actually feeds the other.

[Indiscernible] minor planet Center the ideal place for that to happen?

To me I think so because the keys all the [Indiscernible] why not the [Indiscernible]. [Indiscernible] if they want to take that on they can buy an extra hard drive or to. That was my idea in trying to push what is called [Indiscernible] data exchange program database to them. Is because they get a lot of the commentary in any way as part of the [Indiscernible] report. The idea with [Indiscernible] was to provide not only that the [Indiscernible] data that comes in with all of these [Indiscernible] when someone sits on an asteroid for several hours a night or several nights.

Yes I agree the [Indiscernible] seems logical for that I have thought of it [Indiscernible]. I talk to folks at PDS and I think there are possibilities there including even using the data that is already in [Indiscernible] as part of [Indiscernible] and migrating it to PDS There

are some issues there that I need to work out in talking to programmers and we will see what can happen with that.

The main point was to get it someplace we knew with long-term. I was keeping it just myself and as soon as the beer truck jumped the curb and gets me it is all gone. We need to [Indiscernible] a long term to put it.

Maybe [Indiscernible] I believe some of the groups also attended the workshop last year, some of the coding groups. They are also getting involved [Indiscernible] writing code which makes it easier for amateurs [Indiscernible] to the MPC [Indiscernible] were rather enthusiastic about having any kind of [Indiscernible] to help their development.

I am sure Tim is very happy with signing him up for a whole bunch of new work that isn't currently funded. In fact as you raised Paul the next session we will move into is a little different because it is looking at the current data that MPC has an figure out how the coding committee come together how can designers come together to make it easier for people to interface and build visual Dutchman visualizations [Indiscernible] what is going on a little bit easier.

We will explore that in the next session.

I think there is the question here that is being posed on Which might be a good one to address online. It says is there a single reference for how interested citizens can do for various observations mentioned. I think that is part of the issue we are talking about. There are several great programs out there but [Indiscernible]. I think it is a good chance to [Indiscernible] from the programs we have been talking about.

Let me go first. [Indiscernible] sent out last year we investigated a huge amount of this before the workshop last year but it crystallized in our own minds exactly what we want to do [Indiscernible] and some of the people who are actively monitoring and making sufficient [Indiscernible] asteroids. We very quickly came across the fact that there were more people interested, but there were very few people who knew how to do it who could [Indiscernible].

I disagree slightly with some of the other [Indiscernible] tonight saying you could suggest to train somebody else to do than an hour and let them go. That is not what we found [Indiscernible] meaningful good data at the end of it and actually inspire them to do more than a few hours and leave.

What we came out with is a whole graduation process we invite people in, members come in they apply to join the group and there was a certain level of self learning that they have to do but we provide all of the documentation or that. The members themselves days deserve -- all this learning material which is great it has been honed down over

several generations of graduates coming through. That team basically mentored new people coming in. Date first of all submit their astrometric solutions and results to the group and then peer review those.

Then after they have gone through the whole learning exercise they give the green light [Indiscernible] saying yes you can submit direct to the minor planet Center using [Indiscernible] Observatory codes.

We are there to handhold table through that process, but even that [Indiscernible] could use a certain level of knowledge before they reach that stage before they can enter that program. But what we are actually looking at now we ask it published this first information today we took absolute beginners [Indiscernible] taking people who have not got a clue about any of this may be it is the first time [Indiscernible] asteroid but taking people with zero astronomical knowledge and feeding them up so they can [Indiscernible] telescopes and -- in the Canary Islands in Chile and doing the basics and [Indiscernible] then what you find is in the amateur world a lot of telescopes actually live [Indiscernible] because people have time not because [Indiscernible] but because they have no purpose to use their equipment. Sometimes the perp equipment.

That is what you find any telescope use.

Once people reach that her on the astronomy learning curve, that actually [Indiscernible] for the next step. What can I do with this knowledge what can I do productively. What we find is [Indiscernible] science. That is how we tackle things over the last year at the grand challenge.

You are right about the peer review. The [Indiscernible] center will not accept MPC reports directly from students. We have the validate all the reports before we send the official report to them.

Of the ones who participate in these astronomy campaigns I would say maybe four or five have reached the point that you are talking about where they graduated to the level where they come to me and say I would like to do something else or they would like to do more. We always find some activity for them to get involved in the collaboration to do that. It is a very tiny percent of those who ask to come into the program who actually reached the level that you are talking about. We would become well for them submitting the data directly to the minor planet Center.

It is really good for those sort of people to have something useful [Indiscernible] to be able to go out and measure something and it be useful.

When you get to the point were actually submitting results to an organization to be reviewed, that is a great [Indiscernible] to make and just getting to that point I would

hope would push people on.

[Indiscernible] target out there some of them are more useful than others and just getting people doing stuff, it will just make good measurement.

All these programs kind of feed into each other. Target asteroids [Indiscernible] we are not really meant for the asteroid beginner. Once you have an asteroid beginner who goes to the process either Isaac or [Indiscernible] they learn how to identify asteroids. They can start making photometric observation [Indiscernible] project like ours were [Indiscernible] we'll have a distance to do their own [Indiscernible] we have distance providers with data and we would do that [Indiscernible] for them and the process [Indiscernible] like Brian Warner [Indiscernible] or [Indiscernible] who is on the participant list [Indiscernible]. They can start doing their own autonomy.

I like it when our participants, I don't like it when they leave our group and stop making observations if they move onto something else or start doing main belt light curves or start doing supernova color something like that it is great. Utah do something and they have moved on to the next level. [Indiscernible] all feed into each other.

There is a point to of not trying to have a goal or too much of an emphasis of trying to make sciences out of everybody who comes in. To give them the satisfaction of having [Indiscernible] having an understanding of it, now they become an advocate for science.

School programs, parents, what ever. School programs science sometimes goes by the wayside now you have advocates for science. People who better understand those things so they are that are [Indiscernible]. And so on. If nothing else we can give them a good understanding of the process and enthusiasm for doing something be it science or whatever I think we have done a great disservice regardless if we make [Indiscernible] scientist of a significant number.

Is there -- do you have experience with amateur astronomy clubs or groups versus students whether they are middle school, high school, university level, is there a break between these communities if we are focusing in on this kind of coordinating effort and bringing people in?

In the case of the discovery programs we find that we get more involvement from schools [Indiscernible] but we do have a lot of astronomy groups that participate. One in particular is Venezuela which goes out and recruit about 20 or 30 teams a year to participate in the search campaigns. Most come from the schools.

At least in my experience. Another thing I noticed is there is a greater interest outside the United States with these programs than in the United States. We have a harder time recruiting schools locally or nationally than I do at the international level. I have a long

waiting list of international schools that want to participate. I have to go out and often plead with the schools to become involved. I am not sure why that is the case but that has been my observation.

That is a common problem we have when dealing with schools in the United States because of the testing the teachers are having to adjust their regular two -- curriculum to it has become more difficult to recruit students, but it is not impossible.

Last week there was the symposium on telescope science down in [Indiscernible] California done by the society for astronomical science or astronomical studies. There was a very good synergy and mistreated between the academic communities and the amateur communities there. That is a group we can probably leverage.

We just launched actually a couple of months ago and program called sloop class and has headed up by Michael [Indiscernible] in the USA. The intention of that group is that is where using a collaboration system school teachers and classes can come in they can use telescopes live in the Canary Islands and very much [Indiscernible] based on the US curriculum, science curriculum I am do not know the term of that but I am sure your listeners will know. But we are launching as well another program which is specifically targeted at those [Indiscernible] groups. Exactly the same.

Like astronomy [Indiscernible] where they can come in baby with a joint membership of some kind they can use collaboration tool to actually do their collaboration within their [Indiscernible] society but then they can also use the telescopes as well if they choose to.

We just found the whole purpose of this collaboration system was to allow workshops and interest groups to form.

That was within the [Indiscernible] membership hopefully what we found is there are other organizations out there who are crying out for those kind of tools especially in the astronomical environment that sleugh is in.

By the way if anybody is interested in the sleugh program just e-mail me at Paul.tran25 e-mail me@Paul.tran25.com. I will put you in touch with that program.

One of the things we found certainly in the UK is that you can provide robotic to meter telescopes in Australia and the Canaries and Hawaii, the problem is the teachers just don't have the time to do it.

The curriculum is too constrictive. However, if you have a team teacher with a keen Closser up and running.

What I am concerned about is the amateur astronomers who just want to get on with it

they don't want to be part of a big group or anything like that. They [Indiscernible] easy to understand list of instructions on how to do it.

In my view these are the people that we are trying to encourage you guys deal with a groups and so on that is fine, I am just for the moment more interested in the individual who wants to get going. We have got a huge number of resources out there but they are dispersed, unconnected, hard-to-find and it is very confusing.

If you Google finding asteroids you will get a whole schedule of different websites that all play different things. It doesn't seem to be any way of coming to the right solution for the individual.

Maybe that is the downside of working as an individual you don't benefit from the group [Indiscernible].

There are a huge number of people who do not want to be part of the group.

We have a lot of members to conduct this work on their own. We have quite a few French guys who [Indiscernible] supernova hunt [Indiscernible]. They share their results because they're proud of what they have done as I think most people are if you're working alone if your proud of something you will want to shout it out.

We don't want to dissolute individuals we don't what to say to people you can't come in you can't learn you can't go to the graduation learning process if you don't want to be a part of the group at the in. What we find is most people enjoy it anyway because it does provide motivation.

I think there will always be that problem if you are an individual out there on the Internet trying to find any piece of information it will always be difficult. You always have to have a [Indiscernible] knowledge and that is certainly what we have been trying to pull together and working with people [Indiscernible] to expand back circular information and know-how beyond an organization.

I quite agree with you. Your experience is different to mine. We deal with different people and different circumstances. I am just trying to [Indiscernible] for the guy who wants to do at home in his backyard and doesn't really want to be part of a big group.

I get an awful lot of people who come to visit [Indiscernible] here who say precisely that. How do I get going?

Do have material that these people can use?

Yes we do.

Is that the odds are?

[Indiscernible] national school of so Bertoia which we help put together in the first place for schools. If a school kid can understand that your average amateur can understand it. It seems to work extremely well.

Is a publicly accessible?

What I don't want to do is step on other people's toes were doing the same thing. This is where we come to the problem of multitude different resources that are out there. How you solve this problem frankly I don't know.

If there was an organization like NASA perhaps or MPC who put out the idiot guide on how to do it might be quite helpful.

The [Indiscernible] guide to astrometry -- astronomy is really good.

[Indiscernible] it is pretty complicated stuff.

Is this an opportunity for the IAU sins MPC is a IAU sanction organization is this -- I don't want to say no it is not a NASA world, but I am wondering if that is not an approach. We have already begun conversations with the IAU to figure out how to do some curriculum. It sounds like there is a lot of material already out there it is a matter of curating it in a way so it has a stamp of approval.

[Indiscernible] so much as a [Indiscernible] organization much more NASA was certainly be more so. I think the general public can relate to the NASA person than the IAU.

[Indiscernible - audio cutting in and out] maybe it will help to get involved. I think if it came from a more familiar organization [Indiscernible - audio cutting in and out] The [Indiscernible] center is totally funded by NASA we want the [Indiscernible] to expand it really needs NASA to [Indiscernible] more money. We will need more boots on the ground in order to do that.

I have to say from a European perspective it gives NASA asteroid grant challenge [Indiscernible] I'm not quite sure how many people have heard of the IAU but I know awful lot of people have heard about NASA.

There are enough.

We are going after the big budget people now.

[Indiscernible] he is not going to get any more sleep.

[Indiscernible] to get his head out.

If it were only that easy.

I don't think it matters where this information [Indiscernible] as long as there is a central repository which is [Indiscernible] people don't [Indiscernible] I don't think people would care whether it is on a NASA website or a MPC website or Constable website the argument has been given this information is not freely available as long as it appears in Google searching that will fulfill the need.

As long as it is central and authoritative and as long as it is easy to find [Indiscernible] the heck where it is. At the moment as we said before a [NULL] does not whole slew of stuff happens [Indiscernible] it is jolly difficult if you are beginner to find out where to get going.

Are you talking about a sick astronomy or the [Indiscernible]? We find astronomy is the easy thing people [Indiscernible]. I've been trying to get a hold of Carl for a while to [Indiscernible] and setting up processes to carry out those days codes. That is a missing link for us at the moment.

I must admit I see it as a progression. You start with astronomy you get the hook and then you move on to the complicated stuff which is in my view the spectrometry -- [Indiscernible]. I don't think there are many people other than [Indiscernible] who jump straight into [Indiscernible]. For my expense people move rum astronomy to metonymy -- [Indiscernible]. That does not need a lot of encouragement. Encouragement is to [Indiscernible] in the first place to get through the concept of it being complicated, a black art, I will never be able to hack back, I don't know how you do it etc. etc.

We certainly agree with you there. We are trying to dispel this [Indiscernible] even in the amateur world that this stuff is a black art. It is really down to having a structured teaching really, structured learning, mentoring, some people need a lot of mentoring we have had a lot of students come through and they go from beginning to end [Indiscernible] single question but they have flown through.

The [Indiscernible] curves and the characterization side of things. This is where resources start getting a little more [Indiscernible] because of the telescope resources that are required. That is why we are very specifically taking [Indiscernible] [Indiscernible] from sleugh rather than the general use that we got at the moment.

We are coming from slightly different angles. You have the equipment, I don't. I am just trying to persuade the people who have the equipment to use it for what we would like them to use it for.

We welcome that as well one of things we came to NASA about with the workshop last year was we have the system [Indiscernible] collaboration system that we set up all that was set up and designed so that we can take aim in network of amateurs doing this with their own equipment so we could do that even the learning process educational process as well as coordination [Indiscernible] of this kind of work evil and people are using their own equipment to do it.

One of the interesting things is we are all assuming that people know that there is this the do.

We certainly [Indiscernible] enough. We [Indiscernible] live broadcasts are fairly large audiences to really rate the profile of this. We have been on the campaign now for at least four years we have been doing live shows for [Indiscernible] we are very serious about it about four years ago because frankly [Indiscernible] we have not talked about it in this particular seminar but what has attracted us all to this is we have this fundamental understanding of just how important this work is and every month a month does not go by without a large asteroid being discovered [Indiscernible] approach within days or weeks.

That is certainly one of the big positives that I think [Indiscernible] to get this out into the public and to actually be waving the red flag but with the degree of caution to say you can get involved actually with this. You can do real science and by the way we will teach you how to do it.

That I think is part of why that brand -- grande challenge was announced a year ago with provide greater awareness and start medication to a community not aware of it.

Want to reach out to Peter, I have not heard much. See if you have some thoughts on where this conversation has gone and get some of your thinking.

First off, I am a lone observer I don't really have the experience that these guys have got. I have not brought too many people directly on like that. There are a lot of people out there [Indiscernible] have the enthusiasm to go out and get yourself any sort of telescope to actually get that [Indiscernible] pushed on the bed and had -- as has been talked about [Indiscernible] and make those steps from casual observing to something a bit more [Indiscernible] I think it is a great thing. I put together some webpages that don't really do that, they try and describe the work that I do but has got to be certainly a little ground there where you can bring people on -- there is a lot of equipment out there that can be

used for asteroids that could easily be -- I don't think you ever achieve in that sort of a teaching how to bring somebody on. I am not sure there is even a point in attempting to get a single place to get that.

May be a number of sites that have useful information that are recommended. It is just a case of pushing people on to do something with what we have already got.

Along those lines in the chat box from Kevin [Indiscernible] there is perhaps we need some videos on how to use [Indiscernible] how to locate asteroids and comets -- comet Virchow to telescope newbies. Is that what we are talking about here? Better more accessible education video this work: designers and video as birds -- experts to take what you know and pull it into useful information to get these people active.

[Indiscernible]. Absolutely there is a lot of resources out there MP3 sites that have [Indiscernible] stuff on there. How you use it and how best to find out the right target there is a whole load of stuff. It may not be straightforward to people who have never been there before. It is definitely one-sided.

The other side is using the equipment [Indiscernible] whether it is slew or anywhere using the equipment to actually don't just take one exposure to something you have got to see something moving, you have to [Indiscernible] whatever it is it is not always obvious to people.

There are several sides to it I'm sure.

[Indiscernible]. Sorry go on.

[Indiscernible] can be very valuable but what is the best way to get that visibility? Is it to produce a video and how does the video get distributed? This ago I to YouTube amongst all the other millions of cute cats or whatever. Or is this perhaps a good subject for perhaps some tutorial articles to go into a publication like [Indiscernible].

One of the things you can do is capitalize on the very smart [Indiscernible] very expensive websites as they are already out there.

I am not bashing Nash again but they have a very fine asteroid website.

A little tag at the bottom of that if you want to give it a try click here.

That is probably going to get more people then something in [Indiscernible] telescope.

It doesn't have to be complicated you don't have to spend a lot of money on the videos. It

can be basic stuff. But the guy with the [Indiscernible] who wants to give it a go that is what you need. He can then see three pictures and something moves.

I agree with all of that. Believe it or not that is exactly what we are doing. We got the video tutorials coming out all next week. We found [Indiscernible] to certain audience. We also have got what we are calling a community number ship starting this is where people don't have to telescopes but they benefit from being part of that community.

The one [Indiscernible] slightly parted ways because we found this out [Indiscernible] you can provide any amount of learning information, documentation, videos, whatever media it may be, but somebody always has a question and they need somebody there to ask that question to. That is why I would come back to being able to fall back on a group not necessarily having to sign up [Indiscernible] cut their thumb and signed in blood you are a member of the group just come into the community, dataset from the learning [Indiscernible] and go through that process so you can do it with your own equipment.

This is something in the amateur astronomy world anyway. Whenever I have somebody come to me, e-mail me for advice I say the best thing you can do is find your local astronomical Society, get down there and become part of that..Moves people on in such huge steps whereas actually it can be such a daunting subject even before you start getting into [Indiscernible] areas we're talking about here. It can be so taunting that so many people get up right at the beginning. That is another reason why there is an awful lot of [Indiscernible] sitting in a dusty cupboard.

You are right about the questions in some cases there are lots and lots of questions. In the vast majority of cases we find that they can read the materials and maybe with just a question or two match the process. For those who ask a lot of questions we have a group of volunteers of high school teachers who have been involved in the discovery program for a long time. They are available online through e-mail and Skype and Facebook to communicate with the teachers and students who come to us with questions.

But having a personal contact that mentor ship is important particularly in the beginning.

Do you find that also in target asteroids Karo -- Carl?

We found in order to get participants we have to advertise, advertise, advertise. We had to go a different route. Going to astronomy clubs and talking to them we will get people after every meeting but we found very few of them participate. We found the easiest way to get really productive members of the project was being in astronomy magazine or [Indiscernible] telescope or the [Indiscernible] where we did a cover page article on it. You actually find it is [Indiscernible] I think it was Jake who mentioned that. The loan amateurs who are working their backyard who may not be part of the astronomy club may not be part of the amateur professional organization. They really seem to jump on our project the most and are continuing the most.

Our project really is geared toward brand new people. Obviously you have to have a telescope [Indiscernible] or at least have access to something like 25 -- slew . Most are observers and we do have to help him. They do ask questions. I sit on the phone and talk to people for a few hours explaining how you get a minute [Indiscernible] code Howdy do astronomy, I do get a foot in the door into producing scientifically valuable asteroid data. Most of them are very enthusiastic.

There is a little bit of handholding but that is necessary at first. It pays off because now they are producing data almost every day.

I am hearing a break between, I think somebody described it before, we got the casual observer, enthusiast and then the higher-level expert. It sounds like that is kind of breaking along the lines here as we have gone deeper into this conversation, is not feeling where we ought to focus, I think, the Tesla model where they went with the high-end sports model. Very limited and expanded it into a luxury sedan with the ultimate goal of going very large scale after they have gotten [Indiscernible] big enough to support it.

What I would like to do is we have less than 15 min. We talked about a lot of great issues. How does it seem like we could move forward when we are done here in 15 min. to break this up into some steps that might logically move us further along?

We have been added now for a year talking at least in grand challenge context for a year it is time to start coalescing some real steps to get success here.

Maybe in the next 10 min. or so if we can bring a focus, thoughts you had based on this conversation or other thoughts on what is a reasonable first step out of this conversation.

[Indiscernible] that you want us to do --

We can have a first up until we know what we want at the end. What is the endgame, what do we want to achieve? In all documentation and everything I have seen no aim.

[Indiscernible - multiple speakers]

Ultimately we want to find all asteroid threats and know what to do about them. That is what in the next 10-15 years is what we want to accomplish. [Indiscernible] assumption is the more people characterizing and helping with follow observation that is a great thing to help us. The more people that are aware either using slew or in their backyard now they are active in the political system and saying we need to be spending more resources on this. It is an active, engaged populace that wants to deal with this problem.

We have two aims their.

One to generate political interest and one to produce usable data. So we have a split aim. Not necessarily evolving the same people political side that is what I do. That is very different from producing data.

If we want to produce data we have got to generate interest from the bottom upwards we want to generate political [Indiscernible] we have to do it from again the bottom upwards but it is a different set of people.

I would hope we would do both because when we do our public [Indiscernible] we are broadcasting out to hundreds of thousands of people. And hopefully something we try to do is [Indiscernible] the importance of the entire program. [Indiscernible] if you believe this is important as us then talk to your lyrical representatives. [Indiscernible] you can also get directly involved with science. You can do something straightaway tonight but we certainly hope [Indiscernible] drives that [Indiscernible] Drescher which hopefully helps organizations like NASA get the funding they desperately need.

On the political side I think you and I had the same failure because certainly outside of the United States it really doesn't exist. I am more interested in this discussion on the practical side not the political side. The political side is something, well in the United States for the Americans to worry about, and in Europe for us to worry about.

The practical side that is the tricky one to get the data. We want to increase the amount of data, the amount of good data. We have got to increase the number of people doing it. To do that we have got to start at the bottom and work upwards.

We need [Indiscernible] to be infused to do it not because it is a great political flag-waving talent but because it is fun. If it is not fun they will not do it.

Initially it is great fun you see something move on the screen you think wow I found it. Then there comes a long pause before you are the enthusiast who does it because he loves to do it. It is that central section that is the difficult bit.

That is where the teamwork comes in. That's what gets you from the first step to the last step. It is that collaboration, team spirit, team motivation. I know this sounds terribly American but it is. All that enthusiastic [Indiscernible] incredibly proud of what they do. Actually what we would love to do is [Indiscernible] the competition with it as well. So when we do have multiple teams using these [Indiscernible] that is dedicated to the stuff [Indiscernible] after is quality and quantity in their observation.

That kicks in a huge amount of fun [Indiscernible] fund that you are talking about that people get.

How do we do that?

I believe we are doing it already. We get out to hundreds of thousands of people. We get people coming in. We handhold them from being a total non-astronomer all the way through to making peer reviews, submissions to the minor planet Center. And hopefully in the meantime also having applied pressure to anybody that they can talk to about it. Whether that be there local leader of Parliament in the UK or whoever it is in United States.

How can the rest of us help?

Join. Join Slooh get involved with the program join one of the asteroid resource -- research groups and start doing it. Easy.

[Indiscernible - multiple speakers] .

I will see you there.

No promises.

Actually in the chat question someone typed a quote from [Indiscernible] which says what we don't need more ground-based telescopes that can only observe small patches of sky into [Indiscernible] 20. What he meant was discovery. He did not mean up for characterization.

One of the goals I find from this whole project that is a small fraction of all the photons in telescopes around the world are actually used for science. I think a lot of that is because some people just are not into science [Indiscernible]. Many amateurs don't understand their observations even made with a 4 inch telescope with a regular [Indiscernible] camera can produce good finds.

A lot of the asteroid out there really have not been observed in any detail. Being able to get a light curve or color information you turn that little point of light into the world. In a way we are all kind of armchair explorers. I think one thing we need to do is get across to the amateur community and even the astronomer enthusiast who are actual observers that their observations are useful. They can help further science and they can help expire and -- expand our knowledge. I think getting that excitement out there and saying your observations are needed and useful is very important.

[Indiscernible] might do with target asteroids Carl is when we in the campaign we had maybe 10 or 15 students who participated all the way in the beginning to the end. We can

send them your way. Lot of our amateur astronomers and maybe we can enhance our probe -- your program with participation.

That will be great. And Paul I will e-mail you soon.

[Indiscernible] the other thing we need to do comes back to some of Jason's points what can NASA do. [Indiscernible] to use of telescopes or [Indiscernible] whatever it may be we have got to make it easier for them in two ways. One, to learn what to do. But secondly how to ask a get that data to the people that require. I think going back on the conversation a little bit [Indiscernible] to me in the current position whether it is [Indiscernible] whichever organization I think NASA would be very well-placed to take up that challenge of pushing through somewhere where the data and submission can all be pushed and held.

Final thoughts. Both Bryans we have not heard from either of you in a little bit. We are close to wrapping their.

[Indiscernible] by the discussion. I was going to ask is there on the grand -- challenge page other places to take folks like Slooh and other places discussed here. I know there is not a big thing but at least it would allow folks a quick reference to some of the programs out there without having to go through a Google search [Indiscernible] from your page to their.

I think without -- we had a good discussion here. It is a challenge to get people interested first of all and then to keep going. I don't know that the goal can to be able to keep everyone going but to keep as Carl said get people coming in the door. And [Indiscernible]. The only thing we can do is keep pushing the message and the importance of the work. And I don't disagree it should be fun somehow and we need the resources so it is not difficult to get going.

How those old get managed is lots of work to do. I think we have made good steps, but more will be said and done.

There are some programs out there that do this type of essentially certification. Making sure that people are able to gather data that is of a quality appropriate for [Indiscernible].

If we start looking at programs that are out there that are enabling people to do this astronomy the to do that photometry to do the [Indiscernible] and identify what those are and perhaps it might require something like a non-reversible [Indiscernible]. [Indiscernible] we can call attention to that.

As people become certified on a NASA page somewhere there is as a matter of fact a list of here are the people out there doing this work and we call attention to them we give

some cachet to it and it becomes a competition you look at the number of astrometric submissions that are going in and making some kind of contest of its.

Then we can use existing structures such as the NASA night sky network that involves networks of amateur astronomy clubs again disseminate that and get that out there.

That is one aspect of it. Again, the other aspect is the coordinated data repository.

[Indiscernible] [Indiscernible - multiple speakers] .

If you make it a competition I think you will lose a lot of people. People don't do it as a competitive pastime they do it because they enjoy it.

If you start producing ranking list of things like that I think you will lose people.

I wouldn't advocate that I did of ranking.

I would give up in a heartbeat.

[Indiscernible] sharing the knowledge base but as we have seen [Indiscernible] actually those [Indiscernible] competition in some of those groups who do that. From our point of view I think competition across the board would stop that spread of best practice.

You want quality over quantity.

We want both.

[Indiscernible - multiple speakers] .

It is a very good point but we identified against several different subcommunities if you will and probably the motivation within those communities will very.

All right gentlemen. What a excellent conversation. I really have a sense now. I think what we will do now is we have a wiki page that you can get through to the asteroid initiative page where we can list out what we have heard. And be able to figure out how best to step forward. I think we have got a lot of things that can be done in parallel and it will be a matter of figuring out steps to achieve that.

I encourage through that wiki page we don't have to let this conversation and. We have folks who have tuned in ab -- and have been asking questions and maybe getting some answers in the chat. I would love to see this move into our wiki page as well to enable

that conversation to keep going.

Again, great thanks. Very, very brutal conversation from my perspective and I hope it was enjoyable for you in that this is the continued beginning of making some progress.

Thank you all.

Goodbye for now.

[Event Concluded]